skype a plus sign (+) inside this box → + Approved for use through 9/30/2000. OMB 0651-0032 Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE nder the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

UTILITY
ENT APPLICATION
DANICMITTAI

Attorney Docket No. 9234 First Inventor or Application Identifier O'Brien et al Dental Prosthesis Patter

ADDRESS TO:

TRANSMITTAL	Title	Dental Prosthesis Manufacturing Process, Dental Prost Dental Prosthesis Made Thereby				
Only for new non-provisional applications under 37 C.F.R §1 53(b))	Express	Mail Label No.	EL584205747U	S		
				Assistant Commissioner for Patent		

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents

- Fee Transmittal Form (e.g., PTO/SB/17) (Submit an original and a duplicate for fee processing)
- 2. Specification (Total Pages 15) (preferred arrangement set forth below)
 - Descriptive title of the Invention - Cross References to Related Applications
 - Statement Regarding Fed sponsored R & D
 Reference to Microfiche Appendix
 - Background of the Invention - Brief Summary of the Invention
 - Detailed Description
 - Claim(s) Abstract of the Disclosure
- 3. Drawing(s) (35 U.S.C. 113) (Total Sheets 3)
- 4. Oath or Declaration (Total Pages 3)
 - a.

 Newly executed (original copy)

 b. □ Copy from a prior application 37C.F.R. § 1.63(d) (for continuation/divisional with Box 16 completed)
 - DELETION OF INVENTOR(S) Signed statement attached deleting Inventor(s) named in the prior application, See 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).

*NOTE FOR ITEMS 1 & 13: IN ORDER TO BE ENTITLED TO PAY SMALL ENTITY FEES, A SMALL ENTITY STATEMENT IS REQUIRED (37C.F.R. §1.27), EXCE IF ONE FILE IN A PRIOR APPLICATION IS RELIED UPON 37 C.F.R. § 1.28)

□ Customer Number or Bar Code Label 21905

5.	Microfiche Computer Pro	ogram (Append	ix

- 6. Nucleotide and /or Amino Acid Sequence Submission (if applicable, all necessary)
 a.
 Computer Reads
 - Computer Readable Copy b. Paper Copy (identical to computer copy) Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

Box Patent Application

Washington, DC 20231

- 7. X Assignment Papers (cover sheet & document(s)
- 8. 37 C.F.R. § 3.73(b) Statement Power of Attorney (when there is an assignee)
- 9.

 English Translation Document (if applicable)
- Information Disclosure □ Copies if IDS Citations
- 11. Preliminary Amendment
- 12. Return Receipt Postcard (MPEP 503) (Should be specifically itemized)
- 13. X *Small Entity Statement(s) Statement filed in prior application, (PTO/SB/09-12) Status still proper and desired
- 14. Certified Copy of Priority Document(s)
- (if foreign priority is claimed) 15.
 Other:

16. If a CONTINUING APPLICATION, check appropr	ate box, and supply the	requisite information below and in a preliminary amendmen
Continuation Divisional	Continuation-in	
Prior application information:	Examiner	Group/Art Unit:

FOR CONTINUATION or DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 4b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporate can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

17. CORRESPONDENCE

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	Signature	Hegunor	Date Sept 6	2000
		rm is estimated to take 0.2 hours to complete. Time will vary		
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FEE TRANSMITTAL	Complete if Known				
for FY 2000	Application Number				
Patent fees are subject to annual revision.	Filing Date				
Small Entity payments must be supported by a small entity statement,	First Named Inventor	O'Brien et al			
otherwise large entity fees must be paid. See Forms PTO/SB/09-12	Examiner Name				
See 37 C.F.R. §§ 1.27 and 1.28	Group/Art Unit				
TOTAL AMOUNT OF PAYMENT \$675.00	Attorney Docket No.	9234			

METHOD OF PAYMENT (check one)	FEE CALCULATION (continued)					
The Commissioner is hereby authorized to charge indicated fees and credit any over payment to:	3. AI Large Fee Code	Entity Fee (\$)		Entity Fee (\$)	Fee Description	Fee Paid
Deposit Account Number 03-2830	105	130	205	65	Surcharge - late filing fee	
Deposit Account Name CONNORS & ASSOCIATES	127	50	227	25	Surcharge - late provisional filing fee or	
	139	130	139	130	cover sheet Non-English specification	
Charge Any Additional Fee Required Under 37 CR 1.16 ad 1.17	147	2,520	147	2,520	For filing a request for reexamination	
2. Payment Enclosed:	112	1,840*	113	1,840*	Requesting publication of SIR prior to	
Check Money Order Other	113	2,520	147	2,520	Examiner action Requesting publication of SIR after Examiner action	
FEE CALCULATION	115	110	215	55	Extension for reply within first month	
1. BASIC FILING FEE	116	380	216	190	Extension for reply within second month	
Large Entity Small Entity	117	870	217	435	Extension for reply within third month	
Fee Fee Fee Fee Description	118	1,360	218	680	Extension for reply within fourth month	
Code (\$) Code (\$) FEE PAID	128	1,850	228	925	Extension for reply within fifth month	
101 690 201 345 Utility Filing Fee \$605.00	119	300	219	150	Notice of Appeal	
106 310 206 155 Design Filing Fee	120	300	220	150	Filing a brief in support of an Appeal	
107 480 207 240 Plant Filing Fee	121	260	221	130	Request for oral hearing	
108 690 208 345 Reissue Filing Pee	138	1,510	138	1,510	Petition to institute a public use proceeding	
114 150 214 75 Provisional Filing Fee	140	110	240	55	Petition to revive - unavoidable	
SUBTOTAL (1) (\$) 605.00	141	1,210	241	605	Petition to revive - unintentional	
2. EXTRA CLAIM FEES	142	1,210	242	605	Utility issue fee (or reissue)	
Fee from	143	430	243	215	Design issue fee	
Extra Claims below FEE PAID	144	580	244	290	Plant issue fee	
Total Claims 14 - 20 **= 0 X = 0	122	130	122	130	Petitions to the Commissioner	
Independent 4 - 3 ** = 1 X 30.00 = 30.00	123	50	123	50	Petitions related to provisional applications	
Multiple Dependent Claims =	126	240	126	240	Submission of Information Disclosure Stmt	40.00
**or number previously paid; For Reissues, see below	581	40	581	40	Recording each patent assignment per	
Large Entity Small Entity Fee Fee Fee Fee Description	146	760	246	380	property (times number of properties) Filing a submission after final rejection (37 CR 1.129(a))	
Code (\$) Code (\$) 103 18 203 9 Claims in excess o 20	149	760	249	380	For each additional invention to be examined (37 CR 1.129(b))	
102 78 202 39 Independent claims in excess of 3	Other	fee (speci	fv)			
104 260 204 130 Multiple independent claim if not paid		(speci	-,,			
109 78 209 39 **Reissue independent claims over original patent	Other	fee (speci	fy)			
110 18 210 9 ** Reissue claims in excess of 20 and over						
original patent SUBTOTAL (2) (\$) 30,00					SUBTOTAL (3) (\$) 40.0	n
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SUBMITTED B	Y			Complete (f applicable)
Name (Prins/Type)	John J. Connors	Registration No. (Attorney/Agent)	24,157	Telephone	(949) 833-3622
Signature	Hean	non	er.	Date ×	lept 6, 2000

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE EXPRESS MAIL CERTIFICATION



APPLICANT

: O'Brien et al

TITLE

 $: \ \mathsf{DENTAL}\ \mathsf{PROSTHESIS}\ \mathsf{MANUFACTURING}\ \mathsf{PROCESS},$

DENTAL PROSTHESIS PATTERN & DENTAL PROSTHESIS

MADE THEREBY

DOCKET NO: 9234 CUSTOMER NO: 21905

CERTIFICATE OF EXPRESS MAILING

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EXPRESS MAIL CERTIFICATE NO .:

EL584205747US

By: Binda Ampson

Date: Alen le, 2000

AUTHORIZATION TO CHARGE/CREDIT DEPOSIT ACCOUNT

The commissioner is hereby authorized to charge payment of any fees associated with this communication or credit any overpayment to Deposit Account No. 03-2830.

By: Bath Ellism

Date: Sept. 6, 2000

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	CFR 1.9(f) & 1.27(b))-IN	NDEPENDENT INVENTO	R	9234			
Appl	icant, Patentee, or Identifier	: O'Brien et al					
Appl	ication or Patent No.:						
Filed	or Issued:						
	Dental Prosthesis Manufa e Thereby	cturing Process, Dental Prosthes	is Pa	attern & Dental Prosthesis			
As a l for pu	below named inventor, I hereby urposes of paying reduced fees	y state that I qualify as an independer to the Patent and Trademark Office d	nt inv lescri	rentor as defined in 37 CFR 1.9(c) ibed in:			
\boxtimes	the specification filed herewit	h with title as listed above.					
	the application identified abo	ve.					
	the patent identified above.						
grant inven	, convey, or license, any rights stor under 37 CFR 1.9(c) if that p	red, or licensed, and am under no obli in the invention to any person who w person had made the invention, or to 7 CFR 1.9(d) or a nonprofit organization	ould any	not qualify as an independent concern which would not qualify			
Each oblig	person, concern, or organizatio ation under contract or law to a	on to which I have assigned, granted, assign, grant, convey, or license any ri	conv ghts	eyed, or licensed or am under an in the invention is listed below			
[No such person, concern, o	r organization exists.					
	Each such person, concern,	or organization is listed below.					
	O'Brien Dental Lab, Inc S	State Of Incorporation: Oregon					
	rate statements are required fro ntion stating their status as sma	m each named person, concern, or or ll entities. (37 CFR 1.27)	gania	zation having rights to the			
I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is not long appropriate. (37 CFR 1.28(b))							
Mich NAN	ael J. O'Brien 1E OF INVENTOR	NAME OF INVENTOR	. :	NAME OF INVENTOR			
10	Mil 2:						
Signature of inventor Signature of inventor Signature of inventor							
<	9/5/00						
Date/		Date		Date			

PRO-SIN-09 12-37)
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STATEMENT CLAIMING (37 CFR 1.9(f) & 1.27(b))-IN		Docket Number (Optional) 9234					
Applicant, Patentee, or Identifier: O'Brien et al							
Application or Patent No.:							
Filed or Issued:							
Title: <u>Dental Prosthesis Manufact</u> <u>Made Thereby</u>	uring Process, Dental Prosthesis Process	attern & Dental Prosthesis					
	state that I qualify as an independent in the Patent and Trademark Office descr						
the application identified above							
the patent identified above.	•						
I have not assigned, granted, conveyed grant, convey, or license, any rights in inventor under 37 CFR 1.9(c) if that pe	d, or licensed, and am under no obligati the invention to any person who would rson had made the invention, or to any CFR 1.9(d) or a nonprofit organization u	l not qualify as an independent concern which would not qualify					
Each person, concern, or organization obligation under contract or law to ass	to which I have assigned, granted, conv sign, grant, convey, or license any rights	reyed, or licensed or am under an in the invention is listed below					
No such person, concern, or o	organization exists.						
Each such person, concern, or organization is listed below.							
O'Brien Dental Lab, Inc. State Of Incorporation, Oregon							
Separate statements are required from invention stating their status as small	each named person, concern, or organi entities. (37 CFR 1.27)	zation having rights to the					
I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is not long appropriate. (37 CFR 1.28(b))							
Derrick G. Luksch NAME OF INVENTOR	NAME OF INVENTOR	NAME OF INVENTOR					
Signature of inventor	Signature of inventor	Signature of inventor					
9-5-00	Date	Date					
Date	Date	Date					

FIG. (98.10 L.9)
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	TEMENT CLAIMING SMALL ENTITY STATUS	Docket Number (Optional) 9234
(37 (CFR 1.9(f) & 1.27(c))-SMALL BUSINESS CONCERN	9234
Appli	cant, Patentee, or Identifier: O'Brien et al	
Appl	cation or Patent No.:	
Filed	or Issued:	
	Dental Prosthesis Manufacturing Process, Dental Prosthesis Patt Thereby	tern & Dental Prothesis
NAM	by state that I am the owner of the small business concern identified below: an official of the small business concern empowered to act on behalf of the E OF SMALL BUSINESS CONCERN OBTION DENTAL Lab. Inc. EESS OF SMALL BUSINESS CONCERN 4311 SW Research Way, Corvallise	1112
Office	I hereby state that the above identified small business concern qualifies at d in 13 CFR Part 121 for purposes of paying reduced fees to the United St. Questions related to size standards for a small business concern may be uistration, Size Standards Staff, 409 Third Street, SW, Washington, DC 20-	ates Patent and Trademark directed to: Small Business 416.
conce	I hereby state that rights under contract or law have been conveyed to an in identified above with regard to the invention described in:	d remain with the small business
\boxtimes	the specification filed herewith with title as listed above.	
	the application identified above.	
	the patent identified above.	
entitie an inc	If the rights held by the above identified small business concern are not e m, or organization having rights in the invention must file separate staten s, and no rights to the invention are held by any person, other than the in ependent inventor under 37 CFR 1.99 if that person made the invention, tallify as a small business concern under 37 CFR 1.9(d), or a nonprofit orga- latify as a small business concern under 37 CFR 1.9(d), or a nonprofit orga-	nents as to their status as small wentor who would not qualify as or by any concern which would
Each	person, concern, or organization having rights in the invention is listed be	low
	No such person, concern, or organization exists.	
	Each such person, concern, or organization is listed below.	
inven	ate statements are required from each named person, concern, or organiza- tion stating their status as small entities. (37 CFR 1.27)	
of ent	owledge the duty to file, in this application or patent, notification of any itlement to small entity status prior to paying, or at the time of paying, the enance fee due after the date on which status as a small entity is no longer	earliest of the issue fee or any
NAM	E OF PERSON SIGNING Michael J. O'Brien	
TITLI	OF PERSON IF OTHER THAN OWNER President, O'Brien Dental Lab.	Inc.
ADD	RESS OF PERSON SIGNING 4311 SW Research Way, Corvallis, OR 973	33
SIGN	ATURE MILE DATE 9	15/00

DENTAL PROSTHESIS MANUFACTURING PROCESS, DENTAL PROSTHESIS PATTERN & DENTAL PROSTHESIS MADE THEREBY

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be attached.

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BACKGROUND OF THE INVENTION

Computer technology has advanced to the point where a dental prosthesis may be milled from a solid block of material based on threedimensional digital data corresponding to a proposed shape of the dental prosthesis. The dentist first makes an impression of a patient's existing dentition. Typically, this includes nearby surfaces where the prosthesis is to be located in the patient's mouth. This is accomplished by the dentist first drilling away any unwanted dental tooth structure and then having the patient bite into an impression material that forms a negative impression of the patient's dentition, including the tooth structure to which the dental prosthesis is to be attached. This negative impression is then filled with dental die stone to make a model of the tooth structure to which the dental prosthesis is to be attached and adjacent teeth, particularly the teeth immediately above and to the sides of the tooth structure to which the dental prosthesis is to be attached. This model of the patient's dentition captures an impression of the occlusion surfaces between upper and lower aligned teeth and the configuration of the tooth structure to which the dental prosthesis is to

The computer aided design equipment used to make a dental prosthesis has an scanner that is used to scan the surfaces of the model. Scanning may be accomplished either with optical techniques using laser or non-laser light or tactile techniques where a probe physically contacts the tooth's surface. The computer aided design equipment converts the model's surfaces into three-dimensional digital data corresponding to the physical shape of the model. This original data

collected during scanning is then used to create an image of the proposed shape for the prosthesis on a screen of a computer monitor. The computer aided design equipment is programmed to allow the user, with the aid of a mouse and employing conventional point and click techniques, to change the shape of the image. The original image displayed on the monitor screen needs to be adjusted to modify the original image to correspond to the ultimate shape of the dental prosthesis.

Because the data originally collected during scanning isn't precise enough to make the dental prosthesis directly based on this data, the user can and does make adjustments to the data originally provided by the scanner so that the dental prosthesis, at least in theory, fits properly into the patient's mouth. After making such adjustments to the data collected by the scanner, the adjusted three-dimensional digital data is then forwarded to an automatic milling machine which then mills away the unwanted material from a block to form the dental prosthesis. Typically, the block of material is a ceramic, titanium, or composite plastic material. One of the perceived advantages of this technique is the elimination of conventional investment casting of a wax pattern of the dental prosthesis, which has conventionally been used to make a dental prosthesis.

Although this computer aided design equipment proposes to eliminate conventional investment casting, it suffers from a number of drawbacks that prevent greater utilization of this technology. First, it is impractical to make dental prosthesis from such precious metals as gold and platinum using this technology because so much of the precious metal is lost during the milling process. Second, the adjustments made to the image based on the original data collected during scanning usually fail to create a dental prosthesis that properly fits into the patient's mouth. The inaccuracies in the shape of the dental prosthesis

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so produced using this technology are particularly acute along the marginal edges of the prosthesis adjacent the margins where the treated (drilled) tooth surfaces of an individual tooth are contiguous with the untreated (undrilled) tooth surfaces of this individual tooth.

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SUMMARY OF THE INVENTION

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This invention overcomes the drawbacks associated with the computer aided design technology that eliminates investment casting of a dental prosthesis and directly mills the prosthesis from a block of It has several features, no single one of which is solely responsible for its desirable attributes. Without limiting the scope of this invention as expressed by the claims that follow, its more prominent features will now be discussed briefly. After considering this after reading the and particularly section "DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT," one will understand how the features of this invention provide its benefits, which include, but are not limited to,

- (1) usage of precious metal in making a dental prosthesis with minimum waste of such metal.
- (2) improved accuracy of the marginal edges of the dental prosthesis positioned along the margins of a tooth structure, and
- (3) reduction of time to make a dental prosthesis using conventional investment casting techniques.

The invention includes a method of manufacturing a pattern of a dental prosthesis from a wax material, a method of manufacturing a dental prosthesis itself using this pattern, the dental prosthesis itself, and the pattern used in the manufacture of the dental prosthesis. As used herein, a dental prosthesis includes wax-ups (a term used in the industry) of articulated jaws. These wax-ups constitute an entire array

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of the teeth in an individual patient and they are used for diagnostic purposes. As used herein, "wax material" includes waxes, thermoplastics, combinations of wax and thermoplastic, or other ablative materials that are commonly used in the lost wax process.

The first step of the method of this invention is to form a model of a patient's dentition. This model includes surfaces corresponding to the dental structure nearby the location that the dental prosthesis is to be placed in the mouth of a patient.

The second step is to create three dimensional digital data corresponding to these surfaces, and based at least in part on this data, to create three dimensional digital data substantially corresponding to the dental prosthesis to be manufactured. Typically this is accomplished using a scanner to scan the surfaces of the model to collect three dimensional digital data corresponding to these surfaces. A monitor screen of computer aided design equipment displays an image of a proposed dental prosthesis based, at least in part, on the collected three dimensional digital data corresponding to the surfaces of the model. With the aid of the computer aided design equipment, the image is modified so that the modified image displayed on the monitor screen substantially corresponds to the dental prosthesis to be manufactured.

The third step is to transmit the three dimensional digital data of the dental prosthesis to be manufactured to automated prototyping equipment. Using the automated prototyping equipment, a wax pattern of the dental prosthesis is made from a wax material. This pattern is then used in the lost wax investment casting process to manufacture the dental prosthesis.

In accordance with this invention, the pattern has marginal edges that are at least 3/4 of a millimeter from margins of an individual tooth structure to which the dental prosthesis is to be attached. These set back marginal edges of the pattern are manually adjusted to

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compensate for the specific configuration of the individual tooth structure by adding wax material to these set back marginal edges. This insures that the inaccuracies ordinarily occurring using computer aided design and milling equipment are avoided.

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DESCRIPTION OF THE DRAWING

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The preferred embodiment of this invention, illustrating all its features, will now be discussed in detail. This embodiment depicts the novel and non-obvious method of manufacturing a pattern of a dental prosthesis from a thermoplastic material, and pattern and dental prosthesis made by this method, as shown in the accompanying drawing, which is for illustrative purposes only. This drawing includes the following figures (Figs.), with like numerals indicating like parts:

Fig. 1 is a perspective view of the upper jaw portion of a model for a patient's dentition.

Fig. 1A is an enlarged fragmentary view of part of the upper jaw portion of the model for a patient's dentition shown in Fig. 1, depicting a stump on which a crown type dental prosthesis is to be attached.

Fig. 2 is the monitor screen of computer aided design equipment programmed to create images of different shaped dental prosthesis.

Fig. 3 is the monitor screen of computer aided design equipment displaying how different portions of an image of a dental prosthesis may be modified.

Fig. 4 is another view of the monitor screen showing a dental prosthesis mounted to a tooth structure.

Fig. 5 is a schematic diagram of computer aided design equipment used in the method of this invention.

Fig. 6 is a side elevational view of a treated tooth structure to which a crown type dental prosthesis is to be attached.

Fig. 7 is a schematic diagram of computer aided design equipment connected to automated prototyping equipment that makes a pattern (referred to herein as wax pattern) of the dental prosthesis from wax material

Fig. 8 is a schematic cross-sectional view showing a wax pattern of a crown type dental prosthesis positioned in a casting ring used in investment casting.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In accordance with conventional techniques, a model of a patient's dentition is made. The upper jaw portion 10 of such a model is shown in Fig. 1. A lower jaw portion of this model is also used to collect tooth surface data, but is not shown. For purposes of illustration as shown in Fig. 6, an actual stump 32 to which a crown type 50a dental prosthesis is to be attached includes a drilled away portion 32a and an undisturbed portion 32b next to the patient's gum 34. Where the contiguous borders of the portions 32a and 32b meet, as defined by the line 38, a margin is formed. The jaw portion 10 includes a replicate 32a of the stump 32 to which the crown type dental prosthesis 50a is to be attached.

As shown in Fig. 6, computer aided design equipment 19 creates an image of a dental prosthesis based on data collected from the model of the patient's dentition. As illustrated in Fig. 7, computer aided design equipment sold under the trademark LabQraft™ by Dentalmatic Technologies, Inc. of St. Laurent, Quebec, Canada is modified in accordance with this invention to eliminate milling apparatus connected to an output 19a. In accordance with this invention, this output 19a is

connected to automated prototyping equipment 23. Other similar type equipment such as sold by Decim AB of Skelleftea, Sweden, may also be modified by eliminating the milling equipment and used in accordance with this invention. Suitable automated prototyping equipment 23 is sold under the trademark ModelMaker IITM by Sanders Prototype, Inc. of Merrimack, New Hampshire.

The equipment 19 includes an optical scanner 20 that scans the surfaces of the model of a patient's dentition by directing a beam of light from a source 17 at the model's surfaces, for example, at the tooth surfaces of the upper jaw portion 10. The reflected light represents information corresponding to the contours of these surfaces. This information is collected by a sensor 15 and then stored in the memory 22 of a computer 24 as three dimensional digital data. Various images of a dental prosthesis are displayed on a screen 18 of a monitor 30 connected to an output 32 of the computer 24 based on the data originally collected by the scanner 20. These images, and the corresponding data creating these images, are modified by the user using conventional input devices such as a mouse 26 and keyboard 28 to interact with, and modify, the originally collected three dimensional digital data.

The numeral 12 is an image displayed on the screen corresponding to the actual tooth structure, that is, the stump 32 (Fig. 6) that has been prepared by a dentist for a dental prosthesis. The image 12 is created upon optically scanning the surface of the replicate 32a of the stump 32 and manipulating the collected information of the surface contours, creating the image 12 in accordance with a program 24a that controls processing of the data by the computer 24. As depicted in Fig. 3 and 4, an image 14 of the crown 50a to be attached to the stump 32 is displayed on the monitor's screen 18. In this example, an image 40 of the surface of an upper tooth immediately above and facing the stump

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32 and an image 42 of the surface of the upper adjacent tooth are also displayed on the monitor's screen 18. Through the use of the mouse 26 and keyboard 28 the user can change parameters such as die spacer, minimum thickness of the prosthesis, contact points, grooves, cusp overlays and marginal ridges.

In accordance with this invention, the automated prototyping equipment 23 makes a wax pattern 50 (Figs. 7 and 8) from wax material. This wax pattern 50 is based on the data collected during optical scanning. Typically, the pattern 50 is formed by a series of wax layers laid one upon another until the desired overall shape is completed. The wax pattern 50 formed by the method of this invention is at least 3/4 millimeters from the margin line 38a corresponding to the actual margin line 38 as determined when the pattern 50 is seated by a dental technician on the replicate 32a of a stump 32. In other words, when the user is creating on the monitor screen 18 an image 14 of the crown 50a, the edges 14a of this image 14 are at least 3/4 of a millimeter from an image 38a of the margin line displayed on the screen 18. Consequently, the wax pattern 50 has marginal edges 51 that are displaced at least 3/4 millimeters from the margin line 38a on the replicate 32a that correspond to the actual margin line 38. In accordance with this invention, the edges 51 of the pattern 50 are then manually adjusted to compensate for the specific configuration of the stump 32 by adding a wax material to these edges. This avoids the inaccuracies associated with attempting to make a dental prosthesis that fits properly based solely on computer manipulation of data and then milling the prosthesis from a block of material as dictated by this data.

The wax pattern 50 produced by the automated prototyping equipment 23 is used in the conventional investment casting process to make the crown type dental prosthesis 50a. As shown in Fig. 8, the wax pattern 50 is attached to a sprue 60 made of wax material. This sprue

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60 is mounted to a raised conical portion of a rubber base 62 and a metal ring 64 lined with a sheet 68 of ceramic fiber paper is seated on the base. Preferably, a wax rod 70 extends from a side portion of the pattern 50 to the base 62. The hollow interior 64a of the ring 64 and base 62 is then filled with the investment material, for example, a 6 plaster, that is allowed to dry. After drying the assembly of the base 62, ring 64 and mounted wax pattern 50 is inverted and the base The sprue 60 and wax pattern 50 are next removed by burning them away so that the casting is formed with a hollow cavity (not shown) into which molten metal is poured to form the crown 50a.

SCOPE OF THE INVENTION

The above presents a description of the best mode contemplated of carrying out the present invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains to make and use this invention. This invention is, however, susceptible to modifications and alternate constructions from that discussed above which are fully equivalent. For example, although only crowns have been illustrated, other dental prosthesis such as, for example, bridges and inlays can be made using this invention. Moreover, this method may also be used to make wax-ups of articulated jaws used for diagnostic purposes. Consequently, it is not the intention to limit this invention to the particular embodiment disclosed. On the contrary, the intention is to cover all modifications and alternate constructions coming within the spirit and scope of the invention as generally expressed by the following claims, which particularly point out and distinctly claim the subject matter of the invention:

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THE CLAIMS

- 1. A method of manufacturing a pattern of a dental prosthesis from a wax material, comprising the steps of
- (a) forming a model of a patient's dentition including surfaces corresponding to the dental structure nearby the location that the dental prosthesis is to be placed in the mouth of a patient,
- (b) scanning said surfaces of the model to collect three dimensional digital data corresponding to the said surfaces,
- (c) displaying on a monitor screen of computer aided design equipment an image of a proposed dental prosthesis based, at least in part, on the collected three dimensional digital data corresponding to said surfaces.
- (d) with the aid of said computer aided design equipment, modifying said image so that said image displayed on the monitor screen substantially corresponds to the dental prosthesis to be manufactured,
- (e) collecting the three dimensional digital data substantially corresponding to said image of said dental prosthesis to be manufactured and transmitting said three dimensional digital data of said image of said dental prosthesis to be manufactured to automated prototyping equipment,
- (f) using the automated prototyping equipment making from a wax material the pattern of said dental prosthesis to be manufactured based upon said three dimensional digital data substantially corresponding to said image of said dental prosthesis to be manufactured

- 1 2. The method of Claim 1 where the pattern has marginal edges that
- 2 are at least 3/4 of a millimeter from margins of an individual tooth
- 3 structure to which the dental prosthesis is to be attached.

5 3. The method of Claim 2 where, after step (f), the marginal edges of 6 the pattern are manually adjusted to compensate for the specific 7 configuration of said individual tooth structure by adding wax material 8 to said edges.

- 10 4. A method of manufacturing a dental prosthesis, comprising the11 steps of
 - (a) forming a model of a patient's dentition including surfaces corresponding to the dental structure nearby the location that the dental prosthesis is to be placed in the mouth of a patient,
 - (b) scanning said surfaces of the model to collect three dimensional digital data corresponding to the said surfaces,
 - (c) displaying on a monitor screen of computer aided design equipment an image of a proposed dental prosthesis based, at least in part, on the collected three dimensional digital data corresponding to said surfaces.
- 21 (d) with the aid of said computer aided design equipment,
 22 modifying said image so that said image displayed on the monitor
 23 screen substantially corresponds to the dental prosthesis to be
 24 manufactured.
- 25 (e) collecting the three dimensional digital data substantially
 26 corresponding to said image of said dental prosthesis to be
 27 manufactured and transmitting said three dimensional digital data of
 28 said image of said dental prosthesis to be manufactured to automated
 29 prototyping equipment.

- (f) using the automated prototyping equipment making from a wax material the pattern of said dental prosthesis to be manufactured based upon said three dimensional digital data substantially corresponding to said image of said dental prosthesis to be manufactured, and
- (g) using said pattern in the lost wax investment casting process
 manufacturing said dental prosthesis.
- 9 5. The method of Claim 4 where the pattern has marginal edges that 0 are at least 3/4 of a millimeter from margins of an individual tooth 1 structure to which the dental prosthesis is to be attached.
 - 6. The method of Claim 5 including, after step (f) and prior to step (g), manually adjusting the marginal edges of the pattern to compensate for the specific configuration of said individual tooth structure by adding wax material to said edges.
 - 7. A method of manufacturing a pattern of a dental prosthesis from a wax material, comprising the steps of
 - (a) forming a model of a patient's dentition including surfaces corresponding to the dental structure nearby the location that the dental prosthesis is to be placed in the mouth of a patient,
 - (b) creating three dimensional digital data corresponding to the said surfaces, and based on said data corresponding to the said surfaces, creating three dimensional digital data substantially corresponding to the dental prosthesis to be manufactured,
- 27 (c) transmitting said three dimensional digital data of said dental 28 prosthesis to be manufactured to automated prototyping equipment, 29 and

- (d) using the automated prototyping equipment making from a wax material the pattern of said dental prosthesis to be manufactured based upon said three dimensional digital data of said dental prosthesis.
- 5 The method of Claim 7 where the pattern has marginal edges that 8. 6 are at least 3/4 of a millimeter from margins of an individual tooth 7 structure to which the dental prosthesis is to be attached.
- The method of Claim 8 where, after step (d), the marginal edges of 9. the pattern are manually adjusted to compensate for the specific configuration of said individual tooth structure by adding wax material 12 73 74 75 16 77 18 to said edges.
 - A method of manufacturing a dental prosthesis, comprising the steps of
 - (a) forming a model of a patient's bite registration including surfaces corresponding to the dental structure nearby the location that the dental prosthesis is to be placed in the mouth of a patient,
- (b) creating three dimensional digital data corresponding to the 20 said surfaces, and based on said data corresponding to the said surfaces, creating three dimensional digital data substantially corresponding to 21 the dental prosthesis to be manufactured,
- 23 (c) transmitting said three dimensional digital data of said dental prosthesis to be manufactured to automated prototyping equipment, 24
- 25 (d) using the automated prototyping equipment making from a wax material the pattern of said dental prosthesis to be manufactured 26 27 based upon said three dimensional digital data of said dental prosthesis, 28 and 1031
 - (e) using said pattern in the loss wax investment casting process manufacturing said dental prosthesis.

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that are at least 3/4 of a millimeter from margins of an individual tooth

11. The method of Claim 10 where the pattern has marginal edges

structure to which the dental prosthesis is to be attached.

The method of Claim 11 including, after step (d) and prior to step

(e), manually adjusting the marginal edges of the pattern to compensate

for the specific configuration of said individual tooth structure by

adding wax material to said edges.

The pattern of a dental prosthesis made from a wax material in accordance with the method of Claim 7.

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The dental prosthesis made in accordance with the method of 14. Claim 10.

ABSTRACT OF THE DISCLOSURE

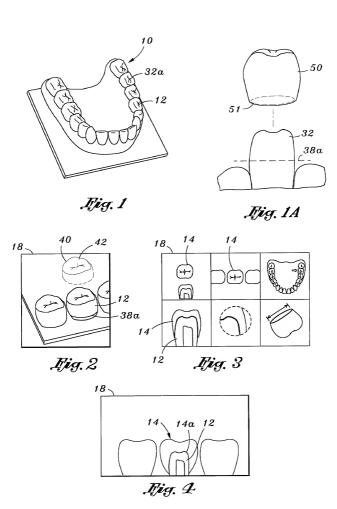
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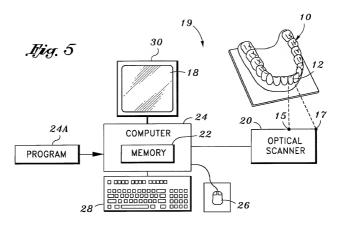
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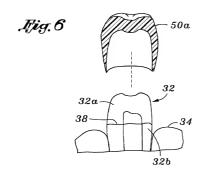
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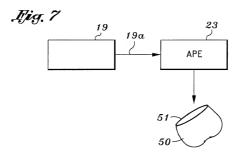
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A dental prosthesis is made by first forming a model of a patient's A three dimensional digital data corresponding to the surfaces of the model is then created. Based on this data, a three dimensional digital data file is then created substantially corresponding to the dental prosthesis to be manufactured. The three dimensional digital data of the dental prosthesis to be manufactured is next to automated prototyping equipment, transmitted and using the automated prototyping equipment, a wax pattern of the dental prosthesis is manufactured based upon this three dimensional digital data of the dental prosthesis. Finally, using this wax pattern in the lost wax investment casting process, the dental prosthesis is made. Prior to investment casting, marginal edges of the wax pattern are adjusted manually.

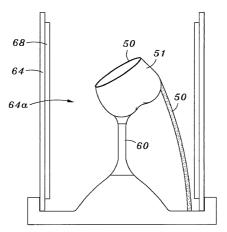












POWER OF ATTORNEY

Assignee, O'Brien Dental Lab, Inc., hereby appoints John J. Connors to prosecute this patent application entitled Dental Prosthesis Manufacturing Process, Dental Prosthesis Pattern & Dental Proshesis Made Thereby (Docket No. 9234), including the power to appoint, substitute, and terminate associate attorneys, and to transact all business in the United States Patent and Trademark Office in connection therewith. John J. Connors is a member of the Bar of the State of California, Patent Office Attorney Registration No. 24,157, whose address and telephone number is Connors & Associates, 1600 Dove Street, Suite 220, Newport Beach, CA 92660-2427, Telephone 949-833-3622, Facsimile 949-833-0885.

Dated:	
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ASSIGNEE: O'Brien Dental Lab, Inc.	
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$\langle n \rangle \langle n \rangle \langle n \rangle$	
By:	
Michael J. O'Brien, President	

Please send all correspondence to the attention of:

John J. Connors Connors & Associates 1600 Dove Street, Suite 220 Newport Beach, CA 92660-2427 Telephone (949) 833-3622 Facsimile (949) 833-0885

PTO/SB/01 (12-97) Approved for use through 9/30/00. OMB 0651-0032

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DECLARATION F	Attorney Docket		234						
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PATENT APPL			COMPLETE IF KNOWN						
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as a below named inventor, I	hereby declare tha	t:							
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he specification of which is attached hereto OR		(Title of the Invention	n)						
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Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

DECLARATION - Utility or Design Patent Application

I hereby claim the benefit under 35 U.S.C. §120 of any United States application(s), or §365(c) of any PCT International application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not

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ADDITIONAL INVENTOR(S) Supplement Sheet Page 3 of 3

Name of Additional Joint Inventor, if any:		A petition has been filed for this unsigned inventor								
								ventor		
Given Name (first and middle [if any]			Family Name or Sur				ırname			
		Luksch								
Inventor's Signature	R. Malante	_			Date	9-9	5-00			
Residence: City	Corvallis	State	O	R	Country	US	Citizenship	US		
Post Office Address	4311 SW Research Way									
Post Office Address										
City	Corvallis	State	C	R	ZIP	97333	Country	US		
Name of Additiona	l Joint Inventor, if any:			A petition	has been	filed for thi	is unsigned in	ventor		
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